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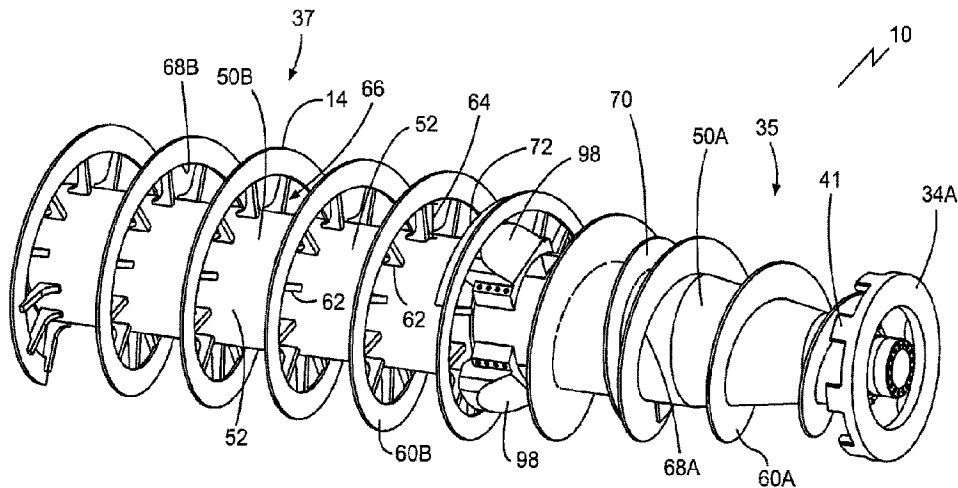
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(54) **Titre : CENTRIFUGEUR DECANTEUR ET METHODES D'UTILISATION ASSOCIEES SERVANT A DESHYDRATER DES
RESIDUS FINS (FLUIDES) MATURES**

(54) **Title: DECANter CENTRIFUGES AND RELATED METHODS OF USE TO DEWATER MATURE (FLUID) FINE TAILINGS**



(57) **Abbrégé/Abstract:**

A decanter centrifuge has: a bowl; a screw conveyor; a feed tube; a feed chamber; an accelerator in the feed chamber; and a feed redirection nozzle; in which the screw conveyor has a conveyor body and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight; in which the decanter centrifuge is structured so that, in use, a feed mixture passes through the feed tube and into the feed zone where the angular velocity of the feed mixture is increased by the accelerator, the feed mixture then passes out of the feed zone, is redirected by the feed redirection nozzle in an axial direction into a sedimentation chamber within the bowl and through the axial flow passage, and the rotation of the conveyor and the bowl cause sedimentation within the bowl, to separate solids and liquids in the feed mixture.

ABSTRACT OF THE DISCLOSURE

A decanter centrifuge has: a bowl; a screw conveyor; a feed tube; a feed chamber; an accelerator in the feed chamber; and a feed redirection nozzle; in which the screw conveyor has a conveyor body and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight; in which the decanter centrifuge is structured so that, in use, a feed mixture passes through the feed tube and into the feed zone where the angular velocity of the feed mixture is increased by the accelerator, the feed mixture then passes out of the feed zone, is redirected by the feed redirection nozzle in an axial direction into a sedimentation chamber within the bowl and through the axial flow passage, and the rotation of the conveyor and the bowl cause sedimentation within the bowl, to separate solids and liquids in the feed mixture.

DECANTER CENTRIFUGES AND RELATED METHODS OF USE TO DEWATER MATURE (FLUID) FINE TAILINGS

TECHNICAL FIELD

[0001] This document relates to decanter centrifuges and related methods of use, for example to dewater mature fine tailings (MFT), also known as fluid fine tailings (FFT).

BACKGROUND

[0002] Decanter centrifuges such as the ALFA LAVAL™ LYNX 1000™ are used to dewater oil sands tailings. The LYNX 1000™ has a radial feed discharge, a conical beach, a cylindrical pond, and a solid flighting conveyor.

SUMMARY

[0003] Decanter centrifuges are disclosed. In one case a decanter centrifuge is disclosed for the purpose of dewatering MFTs. The centrifuge may comprise an accelerator, an axial flow passage within conveyor flighting, and redirection nozzles connected to the feed chamber, as a package for economically processing large volumes of MFTs.

[0004] A decanter centrifuge comprising: a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge; a screw conveyor within the sedimentation chamber, the screw conveyor having a conveyor body, such as a cylindrical tube with or without a conical beach section, and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight; a feed conduit connected to supply a feed mixture of solids and liquids to a feed chamber formed within the conveyor body; and a feed redirection nozzle that is structured to direct the feed mixture from the feed chamber toward the axial flow passage.

[0005] A method is disclosed of continuously processing a feed mixture within a decanter centrifuge, the decanter centrifuge having a bowl and a screw conveyor, the bowl forming a sedimentation chamber with a cake discharge and a centrate discharge, the feed mixture comprising solids and liquids, the method comprising: supplying the feed mixture

through a feed conduit into a feed chamber formed by a conveyor body of the screw conveyor; directing the feed mixture into the sedimentation chamber with a feed redirection nozzle, in which the nozzle directs the feed mixture toward an axial flow passage defined between the conveyor body and an inner edge of a flight mounted to the conveyor body; rotating the bowl and the conveyor body to effect at least a partial phase separation of the solids and liquids of the feed mixture; and discharging solids through the cake discharge, and discharging liquids through the centrate discharge.

[0006] A decanter centrifuge is disclosed comprising: a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge, in which the cake discharge is at or near a first axial end of the bowl, and the centrate discharge is at or near a second axial end of the bowl; a screw conveyor within the sedimentation chamber, the screw conveyor having a conveyor body and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight; a feed conduit connected to supply a feed mixture of solids and liquids to a feed chamber formed within the conveyor body at an intermediate location between the first axial end and the second axial end of the bowl, the feed mixture in some cases comprising mature fine tailings produced from an oil sands process; a feed redirection nozzle structured to direct the feed mixture from the feed chamber toward the axial flow passage; and an accelerator within the feed chamber for increasing the angular velocity of the feed mixture prior to entering the sedimentation chamber.

[0007] A decanter centrifuge is disclosed comprising: a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge, in which the cake discharge is at or near a first axial end of the bowl, and the centrate discharge is at or near a second axial end of the bowl; a screw conveyor within the sedimentation chamber, the screw conveyor having a flight; a feed conduit connected to supply a feed mixture of solids and liquids to a feed redirection nozzle; and the feed redirection nozzle being structured to direct the feed mixture from the feed chamber toward the second axial end of the bowl.

[0008] A decanter centrifuge is disclosed comprising: a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge; a screw conveyor within the sedimentation chamber, the screw conveyor having a conveyor body and a flight;

a feed conduit connected to supply a feed mixture of solids and liquids to a feed chamber formed within the conveyor body, the feed chamber communicating with, for example connected to, the sedimentation chamber via a feed injection port in the outer surface of the conveyor body, the feed mixture comprising mature fine tailings produced from an oil sands process; and an accelerator within the feed chamber for increasing the angular velocity of the feed mixture prior to entering the sedimentation chamber.

[0009] A decanter centrifuge is disclosed comprising: a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge; a screw conveyor within the sedimentation chamber, the screw conveyor having a conveyor body and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight; a feed conduit connected to supply a feed mixture or solids and liquids to a feed chamber formed within the conveyor body, the feed chamber communicating with the sedimentation chamber via a port in the outer surface of the conveyor body, the feed mixture comprising mature fine tailings produced from an oil sands process.

[0010] A decanter centrifuge is disclosed comprising: a bowl; a conveyor; a feed tube; a feed chamber; an accelerator in the feed chamber; and a feed redirection nozzle; in which the decanter centrifuge is structured so that, in use, a feed mixture passes through the feed tube and into the feed zone where the angular velocity of the feed mixture is increased by the accelerator, the feed mixture then passes out of the feed zone, is redirected by the nozzle in an axial direction into a sedimentation chamber within the bowl, and the rotation of the conveyor and the bowl cause sedimentation within the bowl, to separate solids and liquids in the feed mixture.

[0011] A decanter centrifuge may be provided having a conveyor design with; 1) an inlet or feed chamber in which rotational energy may be applied to the feed slurry before the feed flows through the inlet apertures and discharges into the space between the conveyor body and the internal side of the bowl where the separation of the solid constituents is achieved, 2) a part that redirects the feed flow direction towards the liquid end hub as it discharges from the inlet into the space between the conveyor body and the bowl wall. And 3) window ports are cut into the flighting or the flighting is modified such that it is elevated

on posts to provide a space for the redirected flow of the feed to travel unimpeded axially towards the liquid end hub between the conveyor tube body and the top of the flights. The feed flow is now travelling axially towards the liquid end hub with a relatively reduced velocity, a relatively reduced turbulence and a more laminar flow pattern. Such structure is expected to provide for relatively less turbulent flow than in a centrifuge such as the LYNX 1000™ that has solid flighting and no redirection nozzles. The stated structure is expected to allow for greatly improved settling of the suspended solids in the feed, and to minimize shear and hence reducing polymer dosage and centrifuge rotating assembly maintenance requirements.

[0012] Redirection nozzles may be fastened, for example bolted, over inlets (feed zone discharge) to redirect the flow ninety degrees with respect to the feed zone from a radial direction to an axial flow direction in the sedimentation chamber towards the pond hub (clarification section) of the bowl. Such a configuration may reduce turbulence that would otherwise be caused by the influent being introduced radially from the feed zone and heading axially directly toward the bowl wall. Such is expected to eliminate or reduce wear occurring on the conical section. The caulk strips on the bowl extension may have a longer life as well. Conventional larger bowl machines such as the LYNX 1000™ incorporate solid flighting, axial feed ports into the sedimentation chamber, and limited to no means for increasing the angular velocity of the feed mixture prior to supply into the sedimentation chamber, and are used for municipal waste streams. By contrast, MFTs have been found to exhibit excessive wear on conventional centrifuges, thus requiring frequent servicing, decreased clarification, and increased polymer costs.

[0013] In various embodiments, there may be included any one or more of the following features. The nozzle is mounted over an outer surface of the conveyor body, with the nozzle communicating with the feed chamber via a port in the conveyor body. The nozzle defines a hood that forms an elbow-shaped flow passage that connects the port to an axially facing nozzle opening defined by the hood. An outer diameter of the redirection hood is smaller than an inner diameter of the flight. The cake discharge is at or near a first axial end of the bowl, the centrate discharge is at or near a second axial end of the bowl, and the nozzle is structured to direct the feed mixture toward the second axial end of the bowl. The

axial flow passage defines an axial flow path that extends from the nozzle to the second axial end. The bowl comprises a conical beach section defining the first axial end and a cylindrical pond section defining the second axial end, and the flight forms a windowless helix whose inner edge is fused to the conveyor body continuously along a length of the flight throughout the beach section. Plural nozzles radially spaced around the feed chamber. The flight is helically mounted to an outer surface of the conveyor body via a plurality of radial posts such that the helical flight is radially spaced from the conveyor body to define the axial flow passage. A replaceable wear liner is internally mounted to the nozzle to protect the nozzle from abrasion from the feed mixture. The feed chamber is defined between axially spaced plates mounted within the conveyor body. An accelerator within the feed chamber for increasing the angular velocity of the feed mixture prior to entering the sedimentation chamber. The accelerator comprises an impellor with plural vanes. The feed conduit is connected to supply feed mixture to the feed chamber through a port in a first axial end wall of the feed chamber, and the impellor is fixed to a second axial end wall of the feed chamber. The nozzle, or a port that supplies the nozzle and is defined in the outer surface of the conveyor body, is located radially outward of the impellor in a plane, perpendicular to a centrifuge axis, defined by the impellor. The feed chamber comprises a plurality of lobes radially spaced from one another about the second axial end wall within the feed chamber to define a radial feed passage to the nozzle. The radial feed passage has side walls defined by the plurality of lobes and the side walls each mount a replaceable wear liner. A drive connected to simultaneously rotate the screw conveyor and the bowl at different angular velocities relative to one another. The feed mixture comprises mature fine tailings produced from an oil sands process. The feed mixture supplied to the feed chamber comprises a flocculant. The axial flow passage is defined by a plurality of axial windows in the flight. The mature fine tailings comprise solids of 10-45 % by weight of the feed mixture. Operating the decanter centrifuge to effect a phase separation of the solids and liquids in the feed mixture, and producing solids through the cake discharge, and liquids through the centrate discharge. Supplying the feed mixture from a tailings pond, in which the feed mixture comprises mature fine tailings produced from an oil sands process. The feed mixture

prior is flocculated to supplying the feed mixture through the feed conduit. The decanter centrifuge is supported for rotation by oil bath bearings.

[0014] These and other aspects of the device and method are set out in the claims, which are incorporated here by reference.

BRIEF DESCRIPTION OF THE FIGURES

[0015] Embodiments will now be described with reference to the figures, in which like reference characters denote like elements, by way of example, and in which:

[0016] Fig. 1 is a perspective view of a conveyer for a decanter centrifuge.

[0017] Fig. 2 is a side elevation view and schematic of a centrifuge connected to process mature fine tailings (MFT) from a tailings pond.

[0018] Fig. 3 is a section view taken along the 3-3 section lines in Fig. 2 and illustrating a feed tube positioned within the conveyor body.

[0019] Fig. 3A is a section view taken along the 3A-3A section lines in Fig. 3.

[0020] Fig. 3B1 is a section view taken along the 3B-3B section lines in Fig. 3.

[0021] Fig. 3B2 is a perspective view of the portion of the centrifuge as shown in Fig. 3B1.

[0022] Fig. 3C1 is a section view taken along the 3C-3C section lines in Fig. 3.

[0023] Fig. 3C2 is a perspective view of the portion of the centrifuge as shown in Fig. 3C1.

[0024] Fig. 3D1 is a section view taken along the 3D-3D section lines in Fig. 3.

[0025] Fig. 3D2 is a perspective view of the portion of the centrifuge as shown in Fig. 3D1.

[0026] Fig. 4 is a perspective view of a feed redirection nozzle assembled with a wear liner.

[0027] Fig. 5 is an exploded perspective view of the nozzle and wear liner of Fig. 4.

[0028] Fig. 6 is a top plan view of the nozzle of Fig. 4.

[0029] Fig. 7 is a front elevation view of the nozzle of Fig. 4.

[0030] Fig. 8 is a side elevation view of the nozzle of Fig. 4.

[0031] Fig. 9 is a top plan view of one half of the wear liner of Fig. 4

- [0032] Fig. 10 is a bottom perspective view of one half of the wear liner of Fig. 4.
- [0033] Fig. 11 is an end view of the liquids discharge of the centrifuge of Fig. 1.
- [0034] Fig. 12 is an end view of the steel inner plate forming the cake discharge ports at the beach section of the bowl.
- [0035] Fig. 13 is a section view of an oil bath bearing assembly supporting the first axial end of the centrifuge of Fig. 2.

DETAILED DESCRIPTION

- [0036] Immaterial modifications may be made to the embodiments described here without departing from what is covered by the claims.
- [0037] Oil sands may comprise water-wet sand grains held together by a matrix of viscous heavy oil or bitumen. The oil sands may comprise a mixture that is approximately 10% bitumen, 80% sand, and 10% fine tailings. Bitumen is a complex and viscous mixture of large or heavy hydrocarbon molecules, which may contain a significant amount of sulfur, nitrogen and oxygen. The extraction of bitumen from sand using hot water processes yields large volumes of fine tailings composed of fine silts, clays, residual bitumen and water. Fines in such mixtures include clay mineral suspensions or emulsions, predominantly kaolinite and illite.
- [0038] An example fine tailings suspension has 85% water and 15% fine particles by mass. Dewatering of fine tailings occurs very slowly by gravity settling. When first discharged in ponds, the very low density material is referred to as thin fine tailings. Oil sands tailings ponds are engineered dam and dyke systems that contain a mixture of salts, suspended solids and other dissolvable chemical compounds such as acids, benzene, hydrocarbons, residual bitumen, fine silts and water. The Syncrude Tailings Dam or Mildred Lake Settling Basin is a tailings pond that was, by volume of construction material, the largest earth structure in the world in 2001.
- [0039] After a few years when the fine tailings have reached a solids content of about 30-35%, they are referred to as fluid or mature fine tailings (MFTs), which behave as a fluid-like colloidal material. The fact that MFTs behave as a fluid and have very slow consolidation rates at 1 g significantly limits options to reclaim tailings ponds. In fact, fine

tailings will likely never fully settle in these tailing ponds. It is believed that the electrostatic interactions between the suspended particles, which are still partly contaminated with hydrocarbons, prevent settling from occurring. These tailing ponds have become an environmental liability for the companies responsible. A challenge facing the industry remains the removal of water from the fluid fine tailings to strengthen the deposits so that they can be reclaimed and no longer require containment. Many studies and project have been undertaken to address tailings pond remediation.

[0040] Tailings deposited in a tailings pond may contain primarily water, hydrocarbons and solids, which may include mineral material, such as rock, sand, silt and clay. The process described in this document may be useful in reclaiming these ponds by separating the liquid portion from the solid tailings, and using the separated portions to return land to its natural state. However, the apparatus and method may also be applied to any fluid having components to be separated, such as a sewage or solid-liquid mixture. The fluid to be treated may comprise tailings from deep within a tailings pond, without dilution, so long as the tailings are pumpable. If the tailings are not pumpable, they may be made pumpable by dilution with water.

[0041] Decanter centrifuges are used in the mechanical separation process of MFTs from the water in which the tailings are suspended. A centrifuge is a device that employs a high rotational speed to separate components of different densities. A decanter centrifuge separates solid materials from liquids in a slurry. The operating principle of a decanter centrifuge is based on separation via buoyancy. Naturally, a component with a higher density will fall to the bottom of a mixture, while the less dense component will be suspended above it. A decanter centrifuge increases the rate of settling through the use of continuous rotation, producing relatively high g-forces, for example forces equivalent to between 1000 to 4000 g-forces. Such acceleration reduces the settling time of the components by a large magnitude, for example permitting a mixture to settle in seconds in contrast to the same mixture settling in hours, days, years, or longer under ambient g-forces.

[0042] Through the use of decanter centrifuges, settling may be accelerated by flocculating the MFT clay particles, for example using polyacrylamides, and exposing the flocculated feed mixture to relatively high g-force in a decanter centrifuge, such as 1400 g or

higher, to effect phase separation. In such centrifuges, data suggests that the tailings feed creates internal turbulence along the length of the bowl resulting in lessened separation efficiency, increased solids caking along the pond section of the bowl, liquid influx into the beach section of the bowl, and increased wear etching and damage likely from the abrasive sand in such mixtures.

[0043] Referring to Figs. 1-3, a decanter centrifuge 10 is illustrated, having a bowl 12, a screw conveyor 14, and a feed conduit 30. Referring to Fig. 3, bowl 12 forms a sedimentation chamber 33 with a cake discharge 24 and a centrate discharge 26. The screw conveyor 14 is located within the sedimentation chamber 33. The screw conveyor 14 is the part that conveys solid material, which is in the process of settling or has settled in sedimentation chamber 33, to move towards the cake discharge 24. The conveyor 14 may have a conveyor body 50, for example a central hub coaxial with the bowl 12 as shown. The conveyor 14 may have a suitable conveying part, such as a scroll, auger, or helical flight 60. The flight 60 may be helically mounted to an outer surface of the conveyor body. The feed conduit 30 is connected to supply a feed mixture of solids and liquids, for example a feed mixture of MFT, into the sedimentation chamber 33. During use, feed mixture is continually supplied to the sedimentation chamber 33 while the bowl 12 and screw conveyor 14 are rotated. Rotation imparts a centripetal settling force upon feed mixture within the sedimentation chamber 33 to effect at least a partial phase separation between the liquids and solids in the feed mixture.

[0044] Referring to Figs. 2, 3, 3A, and 11, bowl 12 and conveyor 14 may be oriented for co-current or counter-current flow, the latter of which is shown. Referring to Fig. 3, the bowl 12 may be divided into a pond section 37, which may be a straight cylinder, and a beach section 35, which may have a conical shape, for example the shape of a truncated cone. The sedimentation chamber 33 may be defined by an internal encircling wall 32 of bowl 12, a first end plate 34A at a first axial end 34 of rotatably journaled drum or bowl 12, a second end plate 36B at a second axial end 36 of the pond section of the bowl 12. Where a conveyor body 50 is present, the sedimentation chamber 33 is also defined between the conveyor body 50 and the internal encircling wall 32 of bowl 12.

[0045] In a counter-current model as shown, the cake discharge 24, for example radial ports 40, is at or near first axial end 34, while the centrate discharge 26, for example axial ports 42, is at or near second axial end 36. Referring to Figs. 3 and 11, centrate discharge ports 42 may be radially spaced about an axis of rotation 38 of bowl 12. Ports 42 may be positioned to open, and hence drain liquid from, a radius 39A, defined from axis 38, selected to achieve a specific pond depth 39B, defined as radial distance from internal encircling wall 32, within the bowl 12. The selection of the pond depth 39B means the ports 42 act as a weir that takes off a top layer of liquid from fluids in the bowl 12. Referring to Figs. 1, 2 and 3, cake discharge ports 40 may be defined by the spaces between axial projections 41 in a ring plate 34A, for example a steel inner (Fig. 12). The ring plate 34A may be mounted to an axial end of the beach section 35.

[0046] Referring to Figs. 1 and 3, the screw conveyor 14 may be structured to permit axial flow of fluids, for example along an upper surface 63 of feed mixture, in the sedimentation chamber 33. In one case axial flow is permitted radially inward of (as shown), or axially through, flight 60. Referring to Figs. 3, 3C1, and 3C2, an axial flow passage 65 may be defined between the conveyor body 50 and a radially inward facing edge 68B of flight 60, for example pond flight 60B. The axial flow passage 65 may define axial flow path or paths 65 that extend across the pond section 37, for example from a feed inlet such as feed redirection nozzles 98, to the second axial end 36 of bowl 12.

[0047] Permitting axial flow may improve laminar flow of liquids in the chamber 33 and reduce turbulence and fluid velocity. With a solid flighting system, the liquid portion of the slurry must wind its way around the helix of the flight 60 to reach centrate discharge 26. Referring to Fig. 3, by contrast, data suggests that when MFT is processed using a solid helical flight 60 (not shown) in the pond section 37, the liquid is forced to travel, around the helical flow channel defined by the flight 60, toward end 46. Liquids passing around the helix create turbulence that tends to upset settling of the solids in the MFT, carrying such solids all the way up to the second axial end 46 of the pond in some cases. Turbulence may also reduce polymer (floc) size, decreasing settling efficiency and increasing the amount, and hence cost, of flocculant added. Thus, by permitting quasi or fully axial flow of liquids toward the centrate discharge 26, such turbulence is reduced, leading to solid drop out and

settling along the pond section 37, after which conveyor 14 then carries such solids towards the beach section 35.

[0048] Referring to Figs. 1 and 3, in the example shown, axial flow of fluids is achieved by mounting the ribbon flight 60 to an outer surface 52 of the conveyor body 50 via a plurality of radial gussets or posts 62. Thus, the helical flight 60 is radially spaced from the conveyor body 50 to define the axial flow passage or passages 65. A stiffener part, such as a helical bar 72, may be mounted to flight 60 to increase the rigidity of flight 60. In some cases the flight 60 may be mounted on an outer edge of a series of vanes (not shown) that extend parallel to axis 38 and are radially spaced about the conveyor body 50. In further cases, windows (not shown) may be cut through the flight 60 to provide axial flow. The gaps 66 between posts 62, conveyor body 50 and inner edge 68B, or the use of windows in flight 60, may permit quasi or fully axial laminar flow, for example from the feed inlet to the centrate discharge 26.

[0049] Referring to Figs. 1 and 3, the axial flow feature described here is provided on the pond section 37 only in some cases. As shown, the flight 60, for example the part 60A of flight 60 that extends across the beach section 35, may form a windowless helix (solid) that hugs the conveyor body 50, for example by having inner edge 68A of flight 60A fused to the conveyor body 50 continuously along a length, for example the entire length as shown, throughout the beach section 35. In such cases, axial surface flow of liquids is permitted only in pond section 37, but not in beach section 35. A baffle, such as a baffle ring or disc 70, may encircle conveyor body 50A in the beach section 35 to act as a weir that blocks axial and helical travel of liquids toward first axial end 36.

[0050] Referring to Figs. 1 and 3, a feed redirection nozzle or plurality of nozzles 98 may be provided to direct feed mixture, entering the sedimentation chamber 33 from the feed conduit 30, in an axial direction, for example towards axial end 36 and/or toward the axial flow passage 65. Referring to Fig. 3, feed conduit 30 may be connected to supply the feed mixture to a feed zone or chamber 76, which may be formed within the conveyor body 50. The feed conduit 30 may be a non-rotating pipe extended within and coaxial with a rotating internal cylindrical shell 31 formed by the conveyor body 50. In some cases the feed conduit 30 is mounted to rotate. In some cases the feed conduit 30 is mounted to rifle the feed

mixture as it passes through the conduit 30. Each nozzle 98 may be structured to receive feed mixture from the feed chamber 76 via a respective port, such as a radial port 96, in the outer surface 52 of the conveyor body 50, for example in between adjacent rows of flighting 60 as shown. Referring to Fig. 3D2, plural nozzles 98 may be radially spaced about an outer circumference of the conveyor body, for example equidistant from one another to provide a balanced influx of feed mixture, around the feed chamber 76, for example around the conveyor body 50.

[0051] Referring to Figs. 3, 3C2, and 3D2, each nozzle 98 may be mounted over, in some cases integrally projected in a radial direction out of, an outer surface 52 of the conveyor body 50. Referring to Figs. 3 and 4, the nozzle 98 may define a hood 102, for example that is positioned over the outer surface 52 and forms an elbow-shaped flow passage 101 (Fig. 4) that extends from a radial base opening 110 to an axially facing nozzle opening 100. Referring to Fig. 3, the radial base opening 110 may be aligned with the radial port 96 in the conveyor body 50 in use. Thus, feed mixture passes into the nozzle 98, changes direction, for example from radial to an axial direction, and exits the nozzle 98, heading toward the second axial end 36 of the bowl 12.

[0052] With MFT applications, feed mixture supplied via radially directed ports 96 directly into the sedimentation chamber 33 (no nozzles 98), appears to create turbulence, upsetting settled solids passing from the pond to the beach, and in some cases leading to wear in the internal encircling wall 32 of the bowl 12. By contrast, nozzles 98 redirect the feed mixture away from the bowl 12 wall 32 to initiate axial flow in feed supplied to the chamber 33, and thus may reduce disruption to settled solids passing to the beach. The nozzles 98 shown supply feed mixture directly into the pond. Where axial flow paths 65 are defined by the flight 60 and used in combination with nozzles 98, laminar flow may be further improved, and wear on the bowl 12 may be reduced as the jet of feed mixture supplied to the sedimentation chamber 33 passes into the pond, where the energy of the redirected jet is dissipated. Where the nozzles 98 are mounted to the conveyor body 50 and the paths 65 are axially aligned with the openings 100 in the nozzles 98 (Fig. 3), the conveyor body 50, nozzles 98, and paths 65 rotate together and thus always remain in

alignment, avoiding or reducing wear on adjacent posts 62 or sides of flight 60 if windows are used in flight 60.

[0053] Referring to Fig. 3, an outer diameter 107 of the redirection hood 102 is smaller than an inner diameter 64 of the flight 60B.. Therefore, the redirected fluids travel along axial paths that are radially inward of the flight 60B towards the liquid end hub. In one case, a minimum or average radius 69 of the radially inward facing edge 68B of the flight 60 may be greater than or commensurate with a maximum radius 107 of the discharge opening 100 in the hood 102. Both embodiments may reduce or eliminate the effect of the incoming feed mixture jet causing wear on the flight 60, by providing a reduced radial footprint for the nozzle 98. In one design configuration the radius 107 is the maximum radial height of the hood 102 itself. In some cases the distance of the radius 107 is less than or equal to half the radial distance or height 109 of the pond itself. The shorter the radial extension of the hood 102 into the sedimentation chamber 33, the less negative effect, if any, of the hood 102 on settled solids being conveyed from the pond to the beach.

[0054] Referring to Figs. 4-10, an embodiment of a nozzle 98 is illustrated in which a replaceable wear liner 114 is internally mounted to the nozzle 98 to protect the nozzle 98 from abrasion from the feed mixture. The internal flow passage 101 of the nozzle 98 may mount the replaceable wear liner 114. Referring to Figs. 4, 5, and 7, the hood structure of the nozzle 98 may be defined by spaced side walls 104, a rear wall 106, a top wall 108, which may or may not curved, slanted, or curved and slanted, in order to achieve a directional change in the internal flow passage 101. The nozzle 98 may be mounted to the conveyor body 50 by a suitable mechanism, for example fasteners such as bolts (not shown) passed through bolt holes 105 into the conveyor body 50.

[0055] The wear liner 114 may or may not conform to the shape of some or all of the inner surfaces of the nozzle 98 that define the flow passage 101. In the example shown the wear liner is a tungsten carbide insert that is divided into two identical halves 116, though other configurations and number of parts may be used. The wear liner 114 may also have a pair of spaced side walls 118, a rear wall 119, and a top wall 117. The wear liner 114 may be formed of a wear resistant material that acts as a sacrificial part that protects the nozzle 98

from fluid breakout, and that may be replaced periodically at a lesser expense than replacement of the entire nozzle 98.

[0056] Referring to Figs. 3, 3D1, and 3D2, an accelerator, such as an impellor 80, may be provided within the feed chamber 76 for rifling or increasing the angular velocity of the feed mixture prior to entering the sedimentation chamber 33. An impellor 80 may have plural fins or vanes 84, for example formed as a series of flat plates as shown originating from a common point coaxial with the rotational axis 38 of the centrifuge 10.

[0057] A nose, such as truncated cone or rounded knob 82 may project coaxial with the axis 38 in order to divide the incoming feed mixture radially outward, and the rotating vanes 84 may act to induce a vortex or other suitable rotating action on the feed mixture to bring the mixture up to a relatively higher angular velocity prior to sedimentation. By shaping the nose knob 82 as a truncated cone whose pointed end faces the feed conduit 30, air occurring in the feed or having become entrained by the feed while flowing into the inlet may be passed away along the periphery of the knob, thereby preventing an air cushion from occurring in the inlet which may interfere with the intended flow. With the stated design of the projection any liberated air may flow along the periphery of the projection and leave the inlet through the axial bore 79A. The baffle knob may protrude towards the inlet pipe. Such structure may provide for improved control of the inflowing feed when it changes from being an axial flow to being a radial flow by softening or reducing feed zone material acceleration.

[0058] In some embodiments the projection or knob 82 may have substantially radial, longitudinal ribs, such as vanes 84, uniformly distributed around the periphery of the knob 82, for example in a cross-hair configuration. In some cases (not shown) there may be one or more substantially radial ribs (not shown) following helices along the periphery of the projection. A larger momentum may thus be transferred to the liquid in the feed chamber 76 in case the free liquid surface approaches the periphery of the knob 82, because the rate of flow of the feed increases. By altering the shape of the ribs, from rectilinear ribs to ribs that are curved around the projection following a helix, the flow may be directed more strongly towards the ports 96, thereby obtaining an improved axial distribution of the feed. By altering the radial extension of the ribs it may be possible to ensure that the free surface of

the liquid may not approach such a small radius that the liquid back flows out of the feed chamber 76 into the overflow chamber 78 through the annulus defined between the outer wall of the feed tube 30 and the axial bore 79A of the plate 77.

[0059] Referring to Fig. 3, the feed chamber 76 may be defined by a radially confining wall (conveyor body encircling wall 52), a first axial end wall, such as a plate 79, and a second axial end wall, such as a plate 77. Referring to Fig. 3C2, the feed chamber 76 may receive feed mixture through a port 79A in plate 79, for example connected to feed conduit 30. Referring to Figs. 3, 3D1, and 3D2, the impellor 80 may be mounted, for example fixed, to the plate 77. If fixed, impellor 80 will rotate with conveyor body 50, thus inducing vortex action within feed chamber 76 during use.

[0060] Referring to Fig. 3D1, the vanes 84 may, in isolation, be structured to increase the velocity of the feed mixture only part of the way up to the angular velocity of feed mixture in sedimentation chamber 33 (Fig. 3). The ribs or vanes 84 may extend a radial distance 84A from the axis of the impellor 80 (as shown the impellor axis is coaxial with the bowl axis 38 so only the axis 38 is illustrated). The radial distance 84A may be selected to be a portion, for example less than half, of the radial distance 84B from the axis 38 to the convey conveyor body 50 wall 52. The vanes 84 may be radial ribs uniformly distributed along the periphery of the baffle knob 82. The ribs may extend along straight lines or helical lines or other suitable shapes. The vanes 84 may impart a sufficient rotation to the feed in the inlet with the view of obtaining a stable circulation flow in the inlet cavity.

[0061] Referring to Figs. 3D1 and 3D2, the feed chamber may comprise a plurality of lobes 88 radially spaced from one another about the plate 77 to define radial feed passages 90. For example, lobes 88 may be formed in, for example mounted to, the plate 77. The lobes 88 may project out of the plate 77 from respective positions around a circumference of plate 77, for example a peripheral portion 89 of plate 77, and be radially spaced to define radial feed passages 90. Each passage 90 may extend to a respective nozzle 98. The side walls 93 of each lobe 88 in use act upon the feed mixture to further increase the angular velocity of the feed mixture beyond what is achieved with the accelerator. The side walls 93 may be structured, for example curved as shown, to reduce the shock imparted on the feed mixture in transitioning from lower to higher angular velocities. By positioning lobes 88

about the periphery 89 of plate 77, the impellor blades 84 are mounted radially inward of the lobes 88 such that the lobes 88 and vanes 84 complement but do not interfere with one another.

[0062] In the example shown in Fig. 3D1, each side wall 93 of a lobe 88 has the shape of the top surface of an airfoil. For example, each side wall 93 has a sharp, for example planar trailing curve 93B, which may form an obtuse angle with the inside surface of the wall 52 of the conveyor body 50. Each side wall 93 may also have a rounded leading curve 93A, which may wrap back around itself to form an acute angle with the wall 52 of the conveyor body 50. As the conveyor body rotates, the feed mixture, after coming into contact with the impeller and being redirected, is contacted by the leading curve 93A, whose curve imparts rotational force upon the feed mixture in a gentler fashion than would a wall whose surface follows a radius of the feed chamber 76. Each passage 90 may also expand in width up to the discharge port 96 to nozzle 98, in order to create a pressure drop that further accelerates the feed mixture. The side walls 93 may each mount a replaceable wear liner 94, for example made of a suitable sacrificial material, such as tungsten carbide. Other shapes may be used for side walls 93 and liners 94.

[0063] Data suggests that while processing MFT with a traditional decanter centrifuge lacking an accelerator, the feed enters the chamber 33 at a relatively low angular velocity relative to that of materials in the chamber 33, and receives a significant excess amount of energy, resulting in turbulent flow. Such turbulence may be large enough to shear flocculating polymers, reducing polymer size and requiring relatively large amounts of flocculant to achieve the desired agglomerating effect. When an accelerator is used, the incoming feed mixture causes relatively less turbulence, and hence polymer shearing, despite the fact that the incoming feed may not have attained the same angular velocity as the conveyor 14 (in some cases 80% of the bowl 12 speed is achieved). In addition the comparatively long path of flow in the thick liquid layer adjacent the nozzle 98 may permit excess energy to be dissipated in a manner as to prevent or reduce the occurrence of turbulent flows from liquids moving in a helical fashion around flight 60 to the centrate discharge.

[0064] Referring to Fig. 3, the nozzle 98, or a port 96 that supplies the nozzle 98 and is defined in the outer surface 52 of the conveyor body 50, may be located radially outward of the impellor 80 in a plane, perpendicular to a centrifuge axis 38, defined by the impellor 80. Thus, the feed mixture enters the feed chamber 76, changes from an axial to a radial direction under acceleration, and exits the feed chamber 76. Such a configuration causes less turbulence and wear than a configuration where the feed enters the chamber moving in a first axial direction and is forced to change to a second axial direction opposite the first axial direction prior to discharge from the feed zone into the sedimentation chamber, or vice versa.

[0065] Referring to Fig. 2, various parts may be provided to operate the centrifuge 10. For example, a drive, such as a motor and gearbox 22 may be mounted to rotate the bowl 12 and conveyor 14. The gearbox 22 may connect to simultaneously rotate the journaled screw conveyor 14 and the bowl 12 at different angular velocities relative to one another, for example through respective drive shafts (not shown). By rotating the bowl 12 at a different speed, for example 1-100 rpm faster than the conveyor 14 (Fig. 3), the conveyor 14 applies a relatively gentle conveying effect to move settled solids towards the cake discharge 24. In some cases, the drive comprises plural drive motors and gearboxes that each drive and support a respective one of the conveyor 14 or bowl 12, for example if each drive were mounted on a respective axial end 34, 36. One or both the first and second axial ends 34 and 36 may each be mounted to a respective bearing unit 20, such as an oil bath or grease bearing unit, and the bowl 12 and conveyor 14 may rotate around a common axis 38. The centrifuge 10 may be mounted on a suitable structural frame 16, with or without a removable hood or casing 28.

[0066] Referring to Figs. 3, 3B1, 3B2, 3C1, and 3C2, a buffer or overflow chamber 78 may be provided in association with feed chamber 76. The purpose of the overflow chamber 78 is to provide an alternate route for feed mixture to enter the sedimentation chamber 33 in the event that the feed chamber 76 becomes plugged or restricted, for example as a result of over feeding. In the example shown the overflow chamber 78 is axially closer to axial end plate 34A, such that feed mixture travels from conduit 30, through a port 81A in a plate 81, axially through the overflow chamber 78, and through port 79A in plate 79 to enter the feed chamber 76.

[0067] Overflow chamber 78 may incorporate one or more of the features disclosed in this document for feed chamber 76 and nozzles 98. The overflow chamber 78 is shown with purely radial outlets 124, although nozzles (not shown) may be mounted over such outlets 124, and in some cases radially staggered so as not to be interfered with by the position of nozzles 98 of feed chamber 76. The plate 77 may incorporate axial lobes 120 whose side walls define radial passages 122 to ports 124. Thus, if feed chamber 76 becomes plugged, back pressure builds, forcing incoming feed mixture to pass through passages 122 and ports 124 into chamber 33, rather than traverse feed chamber 76. The overflow chamber 78 is intended to provide a temporary solution to plugging without locking the system up completely and causing a potentially damaging high pressure situation.

[0068] Referring to Figs. 2 and 3, centrifuge 10 may be used in a continuous process to effect a phase separation of a feed mixture. As above, feed mixture, such as including MFTs produced from an oil sands process, may be supplied through a feed conduit 30 into a feed chamber 76. Nozzles 98 may be used to direct the feed mixture into the sedimentation chamber 33, in which the nozzle directs the feed mixture toward an axial flow passage 65 defined between the conveyor body 50 and an inner edge 68B of a conveyor flight 60. The bowl 12 and conveyor body 50 may be rotated to effect at least a partial phase separation of the solids and liquids of the feed mixture. Solids may be discharged through the cake discharge 24, and liquids discharged through the centrate discharge 26.

[0069] Feed mixture may be supplied to chamber 33 via feed conduit 30 by a suitable pumping mechanism, and in a continuous fashion. For example, feed conduit 30 may enter the centrifuge by passing through a bearing unit 20 in one of the axial ends 34, 36, and connecting to the internal feed box or chamber 76 (Fig. 3). In some cases the feed mixture may comprise mature fine tailings produced from an oil sands process, for example if the feed conduit 30 is connected to receive such a feed mixture. In the example shown, a pump 136 draws MFT from a tailings pond 134, at a level sufficiently below the pond surface 132 to access MFT. In other cases, other types of fluids from tailings pond 134 may be accessed. The MFT is pumped via line 130 to feed conduit 30. Other pre-centrifuge processing steps may be carried out, for example to heat or dilute the MFT by addition of water.

[0070] The feed mixture supplied to the feed chamber 76 may also comprise a suitable flocculant. In flocculation, a chemical is added to agglomerate particles, which may be destabilized by addition of a coagulant, into relatively large particles colloquially called flocs, whose relatively large molecular weight causes an increase in density and drop out from the liquid phase. Flocculants include relatively high molecular weight, water soluble organic polymers. A flocculant may be added from a suitable source, such as a tank 138, using machinery such as an addition pump 140 and a mixer in some cases (not shown).

[0071] Phase separated materials, such as liquids and solids discharged from centrifuge 10, may be subject to further processing or disposal as desired. For example, solids from cake discharge 24 may be ejected onto a conveying device 142, which may transport same to a disposal area 144. Liquids remove from centrate discharge 26 may be transported via a line 146 to a suitable disposal site, such as the tailings pond 134 where the feed mixture was taken from. Oil and water separation may be carried out on centrate to remove entrained bitumen. Connections and communication between parts may occur through intermediate components. Radial ports 96 may have a suitable position and shape, for example such may be spaced radially and axially from one another, in a helical fashion. Ports 96 may be circular, oval, or other suitable shapes.

[0072] Referring to Fig. 13, an example of an oil bath bearing assembly 20 is illustrated supporting the first axial end 34 of the centrifuge. A similar oil bath bearing unit may support the other axial end of the centrifuge. The bearing assembly 20 may rest on an external part or ledge of the casing 28 as shown, below a lid 150 of the casing, and may receive a rotating shaft 152 extended from bowl 12. The feed conduit (not shown) may extend through the interior of the shaft 152 in use to supply feed mixture to the centrifuge. Inboard and outboard seals, such as labyrinth seals 158A, and 158B, respectively may be positioned on either axial end of a pillow block 162, which sits over top a bearing 160 and defines an oil bath chamber 164. Bearing 160 receives oil from a nipple 162, and oil drain ports 162 may be located at the base of the chamber 164 for removing oil from the oil bath chamber 164.

[0073] Labyrinth seals 158A and 158B may not contact the shaft 152, and may be provided with sufficiently close tolerance to shaft 152 such that the ingress of cake into the

bearing 20 is reduced relatively to a conventional grease bearing. Also, the provision of the oil bath bearing 20 outside the casing 28 reduces ingress of cake into the unit. Moreover, the cycling of an oil bath through the unit acts to flush out particulates that find their way into the unit 20, further extending part life. It is believed that such bearings may have a field life of five or more years, as opposed to the relatively shorter life span of an internal grease bearing, particularly in the context of processing highly abrasive MFT cake.

[0074] There may be provided a close fit between an outer edge 71 of flight 60 and the bowl 12, such as 1-2 mm or other distances. More than one flight 60 may be provided, for example a double helix. Flights 60A and 60B may be separate or connected flights. Bowl 12 speeds of 800 - 4000 rpm may be used or other suitable speeds. Conveyor flighting 60 may have a suitable rake, such as a positive, negative, or neutral (as shown) rake.

[0075] A centerless conveyor may be used, for example without a central conveyor body 50. Centrifuge 10 may be used in applications other than processing MFT from oil sands, such as processing tailings from a mining process. MFTs may comprise solids of 10-45 % by weight of the feed mixture, although other ranges may be used. A vertical or horizontal centrifuge may be used. A co-current or counter-current flow may be used. A solid bowl 12 may be used with a conical, cylindrical, and cylindrical-conical configuration.

[0076] The centrifuge 10 may be used to effect a liquid-gas-solid, liquid-liquid, gas-liquid separation, or other suitable arrangements. Nozzles 98 may impart a direction change of ninety degrees to the feed mixture. In some cases the nozzles 98 may direct the feed mixture in an axial direction, which may be a vector with a dominant axial scalar component, and forming an angle with respect to axis 38 of less than forty five degrees, for example less than ten degrees and in some cases zero degrees. The conveyor body 50 may be solid or hollow as shown.

[0077] The mouth of the inlet apertures (for example nozzles) may be located on a radius greater than the radius to the outlet openings, such that a peripheral area of the inlet outwardly defined by the radius to the inlet apertures is free of carriers, inwardly extending projections. Parts of the centrifuge 10 may be arranged to inherently balance the device, for example by uniformly distributing nozzles, feed passages, and other parts radially about the circumference of conveyor body 50. Weight balance may be achieved by arranging

components to have a center of gravity along axis 38 during use. The impellor 80 and the lobes 88 may be fastened to the plate 77, for example in a removable fashion to permit removal in case such was not needed with the particular feed mixture processed, or in order to replace a worn part.

[0078] Plates or hubs 34A and 36A (Fig. 3) may each have an axial opening 44, 46, respectively, for various purposes such as receiving the feed conduit 30 and/or mounting drive shafts or bearings. Beach part 50B of conveyor body 50 may be shaped in a conical fashion to follow the shape of the beach section 35 of bowl 12. In one embodiment the inlet pipe or feed conduit 30 may be repositioned, for example along the axis 38 to adjust the distance between the outlet of the feed conduit 30 and the knob 82 or accelerator. Thus, the diameter of the feed jet at the baffle knob 82 may be altered by displacement of the feed conduit, thereby making it possible to adapt the flow in the feed chamber 76 to the type of feed and/or the rate of flow thereof. The impellor 80 may be geared to rotate faster or slower than the rotation of conveyor body 50. Flocculant may be added to the feed mixture before, during, or after (by injection into the sedimentation chamber) the feed mixture is supplied to the sedimentation chamber section. Radially spaced may refer to the fact that parts are spaced about a circumference of an object, whether the circumference is taken by a cross-section or is projected into a plane.

[0079] In the claims, the word “comprising” is used in its inclusive sense and does not exclude other elements being present. The indefinite articles “a” and “an” before a claim feature do not exclude more than one of the feature being present. Each one of the individual features described here may be used in one or more embodiments and is not, by virtue only of being described here, to be construed as essential to all embodiments as defined by the claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A decanter centrifuge comprising:
 - a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge;
 - a screw conveyor within the sedimentation chamber, the screw conveyor having a conveyor body and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight;
 - a feed conduit connected to supply a feed mixture of solids and liquids to a feed chamber formed within the conveyor body; and
 - a feed redirection nozzle that is structured to direct the feed mixture from the feed chamber toward the axial flow passage.
2. The decanter centrifuge of claim 1 in which the feed redirection nozzle is mounted over an outer surface of the conveyor body, with the feed redirection nozzle communicating with the feed chamber via a port in the outer surface of the conveyor body.
3. The decanter centrifuge of claim 2 in which the feed redirection nozzle defines a hood that forms an elbow-shaped flow passage from the port to an axially facing nozzle opening defined by the hood.
4. The decanter centrifuge of claim 3 in which the hood is positioned radially inward of the flight.
5. The decanter centrifuge of any one of claim 1 - 4 in which the cake discharge is at or near a first axial end of the bowl, the centrate discharge is at or near a second axial end of the bowl, and the feed redirection nozzle is structured to direct the feed mixture toward the second axial end of the bowl.

6. The decanter centrifuge of claim 5 in which the axial flow passage defines an axial flow path that extends from the feed redirection nozzle to the second axial end.
7. The decanter centrifuge of claim 6 in which the bowl comprises a conical beach section defining the first axial end and a cylindrical pond section defining the second axial end, and the flight forms a windowless helix whose inner edge is fused to the conveyor body continuously along a length of the flight throughout the beach section.
8. The decanter centrifuge of any one of claim 1 - 7 further comprising plural feed redirection nozzles radially spaced around the feed chamber.
9. The decanter centrifuge of any one of claim 1 - 8 in which the flight is a helical flight mounted to an outer surface of the conveyor body via a plurality of radial posts such that the helical flight is radially spaced from the conveyor body to define the axial flow passage.
10. The decanter centrifuge of any one of claim 1 - 9 in which an internal flow passage of the feed redirection nozzle mounts a replaceable wear liner.
11. The decanter centrifuge of any one of claim 1 - 10 in which the feed chamber is defined between axially spaced plates mounted within the conveyor body.
12. The decanter centrifuge of any one of claim 1 - 11 further comprising an accelerator within the feed chamber for increasing the angular velocity of the feed mixture prior to entering the sedimentation chamber.
13. The decanter centrifuge of claim 12 in which the accelerator comprises an impellor with plural vanes.

14. The decanter centrifuge of claim 13 in which the feed conduit is connected to supply feed mixture to the feed chamber through a port in a first axial end wall of the feed chamber, and the impellor is fixed to a second axial end wall of the feed chamber.
15. The decanter centrifuge of claim 14 in which the feed redirection nozzle, or a port that supplies the feed redirection nozzle and is defined in the outer surface of the conveyor body, is located radially outward of the impellor in a plane, perpendicular to a centrifuge axis, defined by the impellor.
16. The decanter centrifuge of any one of claim 14 - 15 in which the feed chamber comprises a plurality of lobes radially spaced from one another about the second axial end wall within the feed chamber to define a radial feed passage to the feed redirection nozzle.
17. The decanter centrifuge of claim 16 in which the radial feed passage has side walls defined by the plurality of lobes and that each mount a replaceable wear liner.
18. The decanter centrifuge of any one of claim 1 - 17 further comprising a drive connected to simultaneously rotate the screw conveyor and the bowl at different angular velocities relative to one another.
19. The decanter centrifuge of any one of claim 1 - 18 in which the feed mixture comprises mature fine tailings produced from an oil sands process.
20. The decanter centrifuge of claim 19 in which the feed mixture supplied to the feed chamber comprises a flocculant.
21. A method comprising operating the decanter centrifuge of any one of claim 1 - 20 to effect a phase separation of the solids and liquids in the feed mixture, and producing solids through the cake discharge, and liquids through the centrate discharge.

22. A method of continuously processing a feed mixture within a decanter centrifuge, the decanter centrifuge having a bowl and a screw conveyor, the bowl forming a sedimentation chamber with a cake discharge and a centrate discharge, the feed mixture comprising solids and liquids, the method comprising:

supplying the feed mixture through a feed conduit into a feed chamber formed by a conveyor body of the screw conveyor;

directing the feed mixture into the sedimentation chamber with a feed redirection nozzle, in which the feed redirection nozzle directs the feed mixture toward an axial flow passage defined between the conveyor body and an inner edge of a flight mounted to the conveyor body;

rotating the bowl and the conveyor body to effect at least a partial phase separation of the solids and liquids of the feed mixture; and

discharging solids through the cake discharge, and discharging liquids through the centrate discharge.

23. The method of claim 22 further comprising supplying the feed mixture from a tailings pond, in which the feed mixture comprises mature fine tailings produced from an oil sands process.

24. The method of any one of claim 22 - 23 further comprising flocculating the feed mixture prior to supplying the feed mixture through the feed conduit.

25. A decanter centrifuge comprising:

a bowl forming a sedimentation chamber with a cake discharge and a centrate discharge, in which the cake discharge is at or near a first axial end of the bowl, and the centrate discharge is at or near a second axial end of the bowl;

a screw conveyor within the sedimentation chamber, the screw conveyor having a conveyor body and a flight, the screw conveyor defining an axial flow passage between the conveyor body and a radially inward facing edge of the flight;

a feed conduit connected to supply a feed mixture of solids and liquids to a feed chamber formed within the conveyor body at an intermediate location between the first axial end and the second axial end of the bowl, the feed mixture comprising mature fine tailings produced from an oil sands process;

a feed redirection nozzle structured to direct the feed mixture from the feed chamber toward the axial flow passage; and

an accelerator within the feed chamber for increasing the angular velocity of the feed mixture prior to entering the sedimentation chamber.

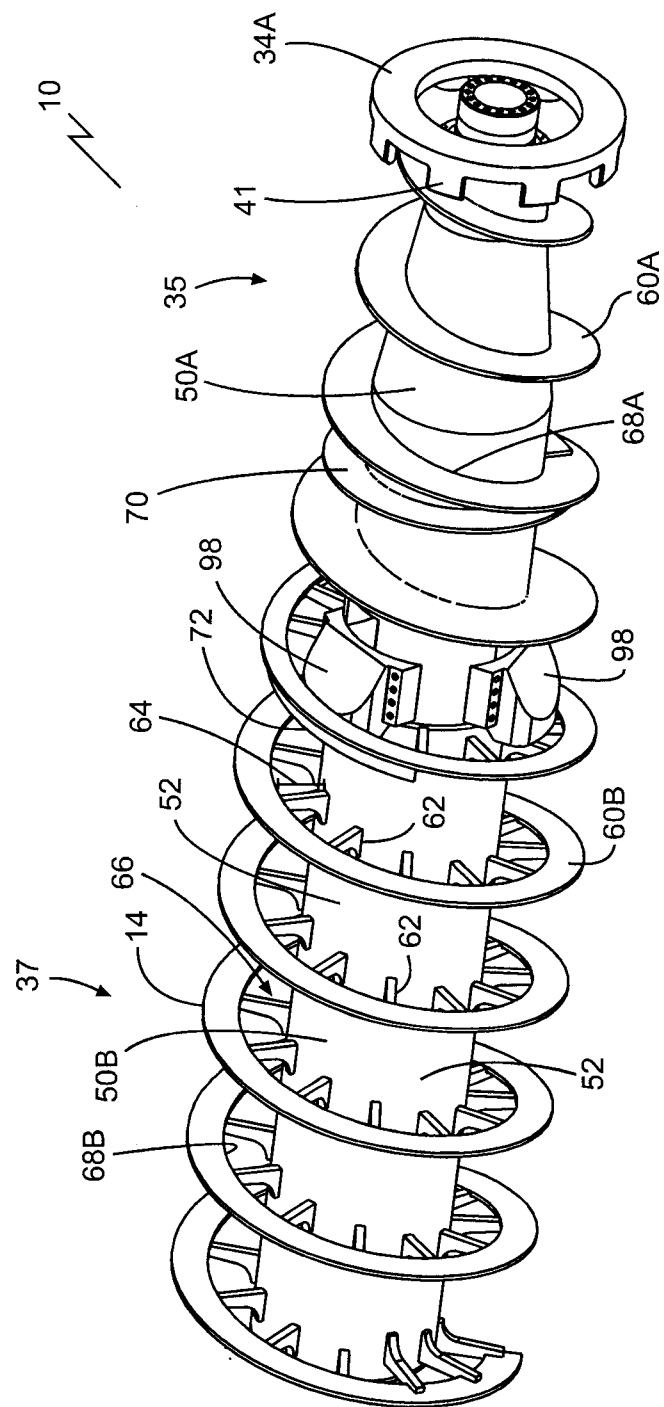


Fig. 1

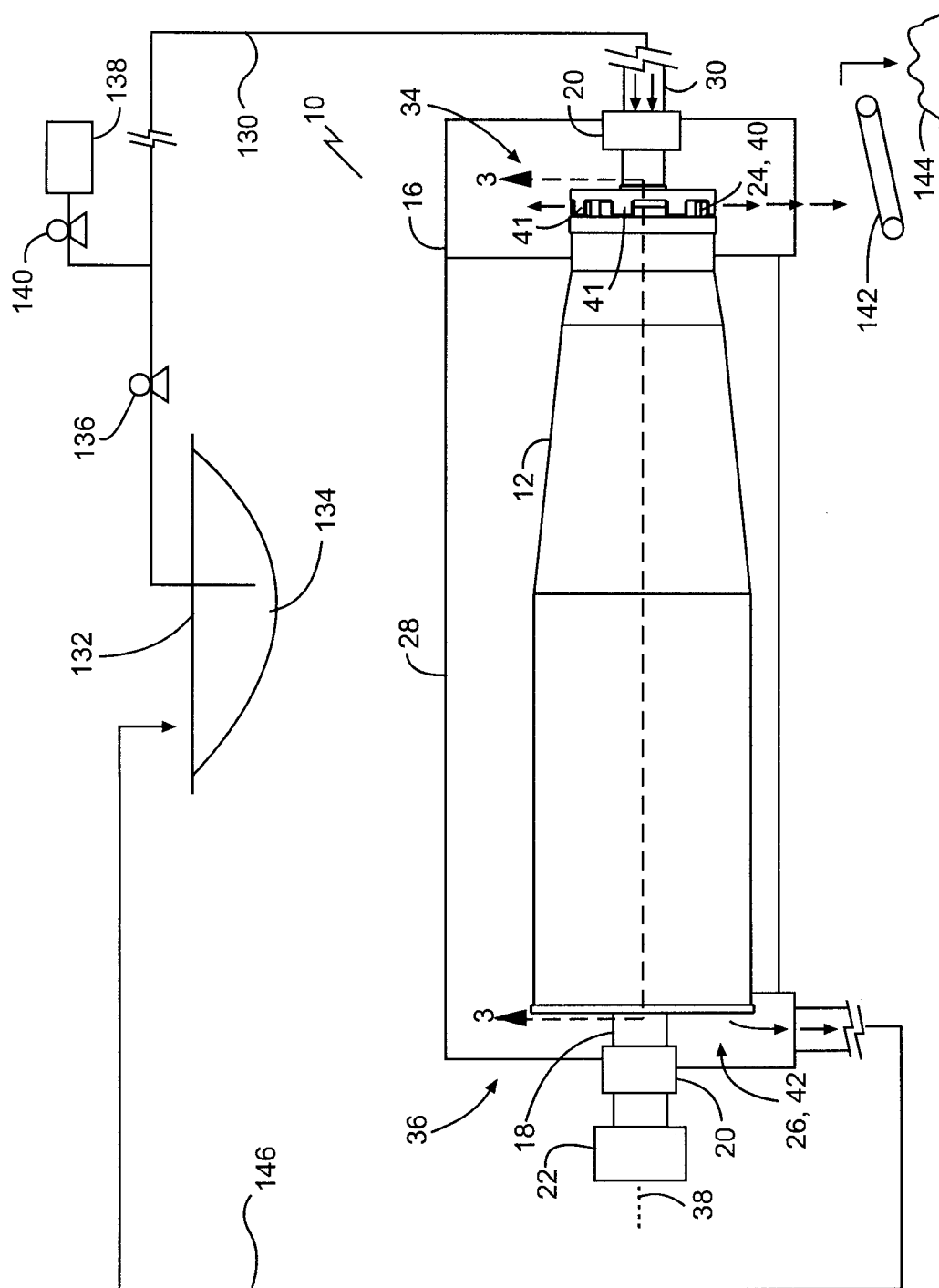


Fig. 2

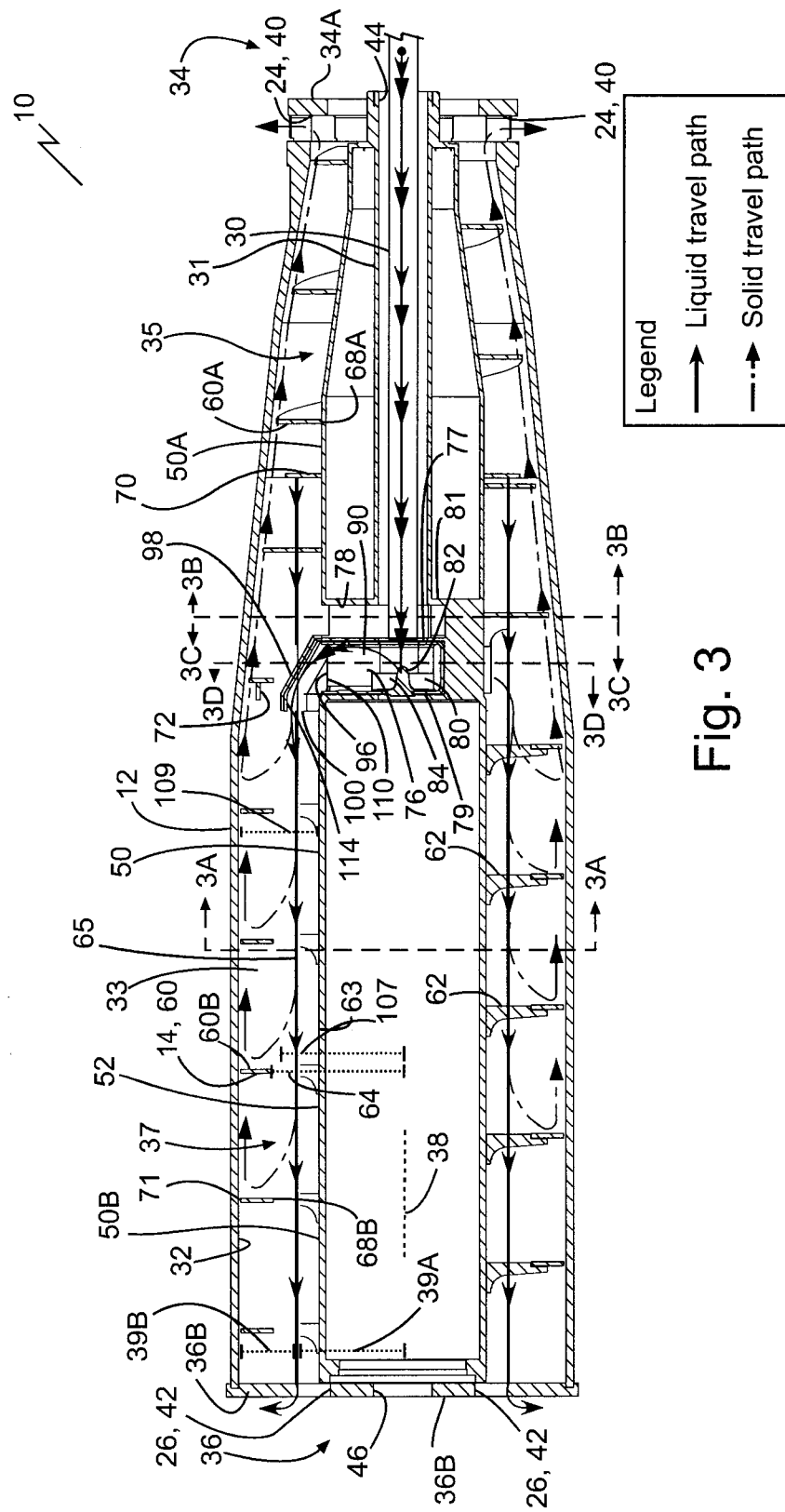


Fig. 3

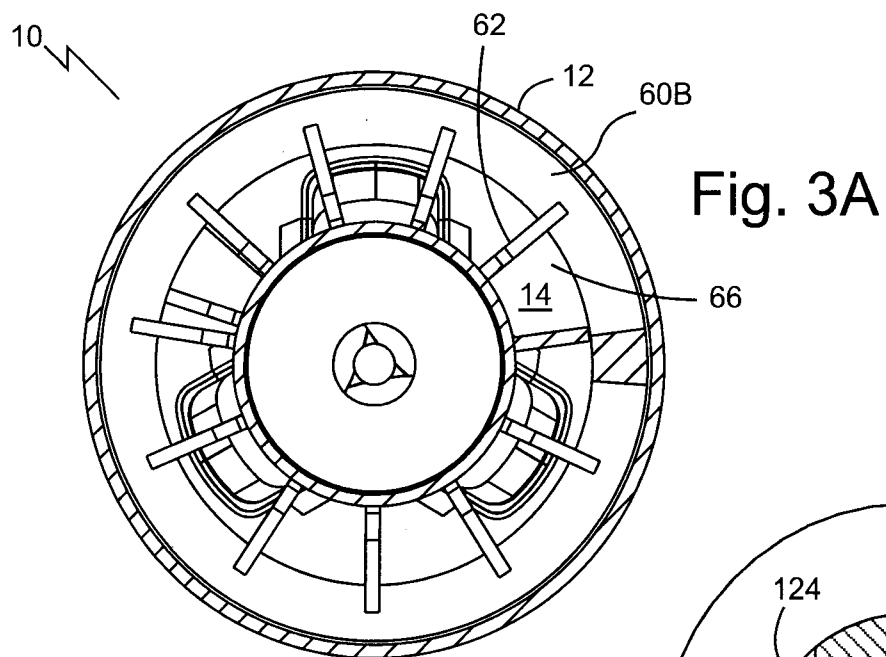


Fig. 3A

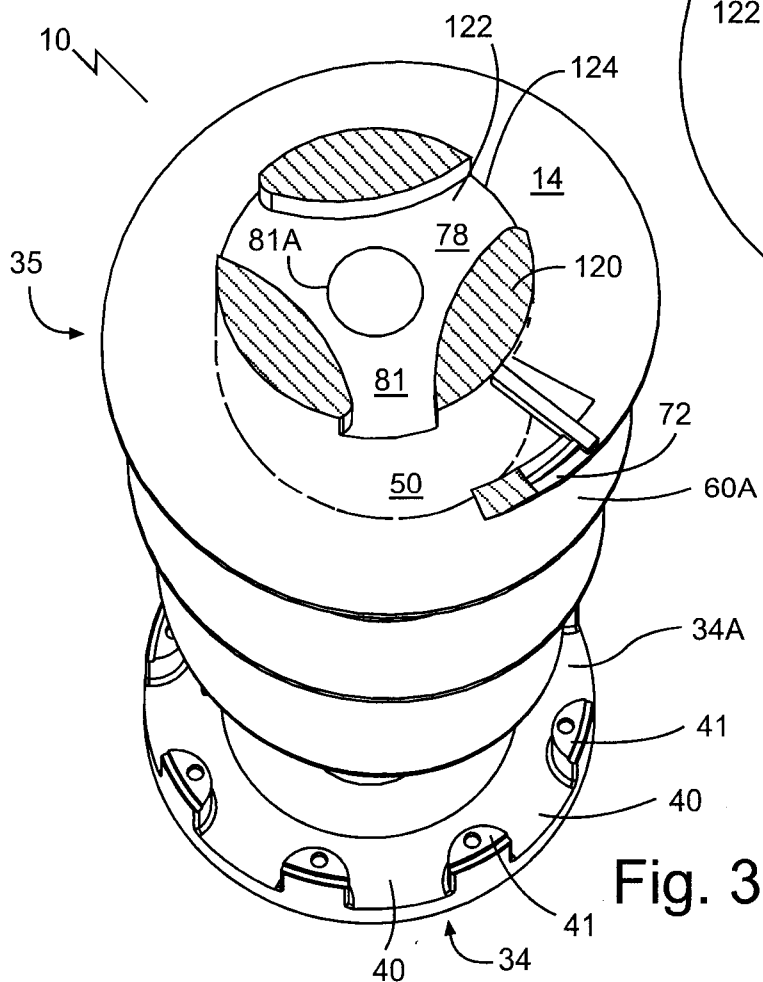


Fig. 3B2

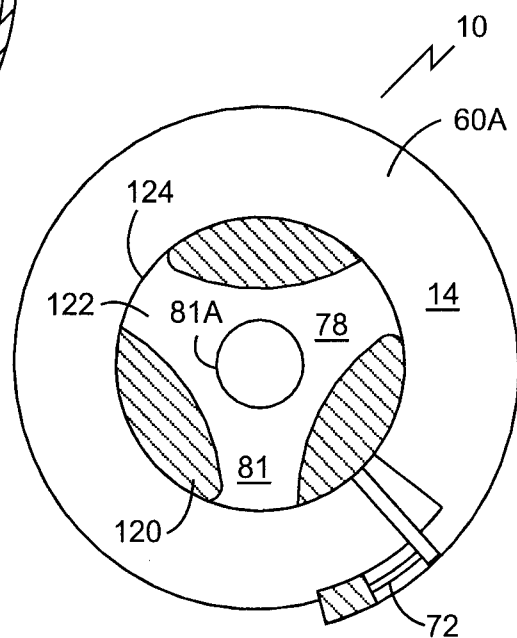
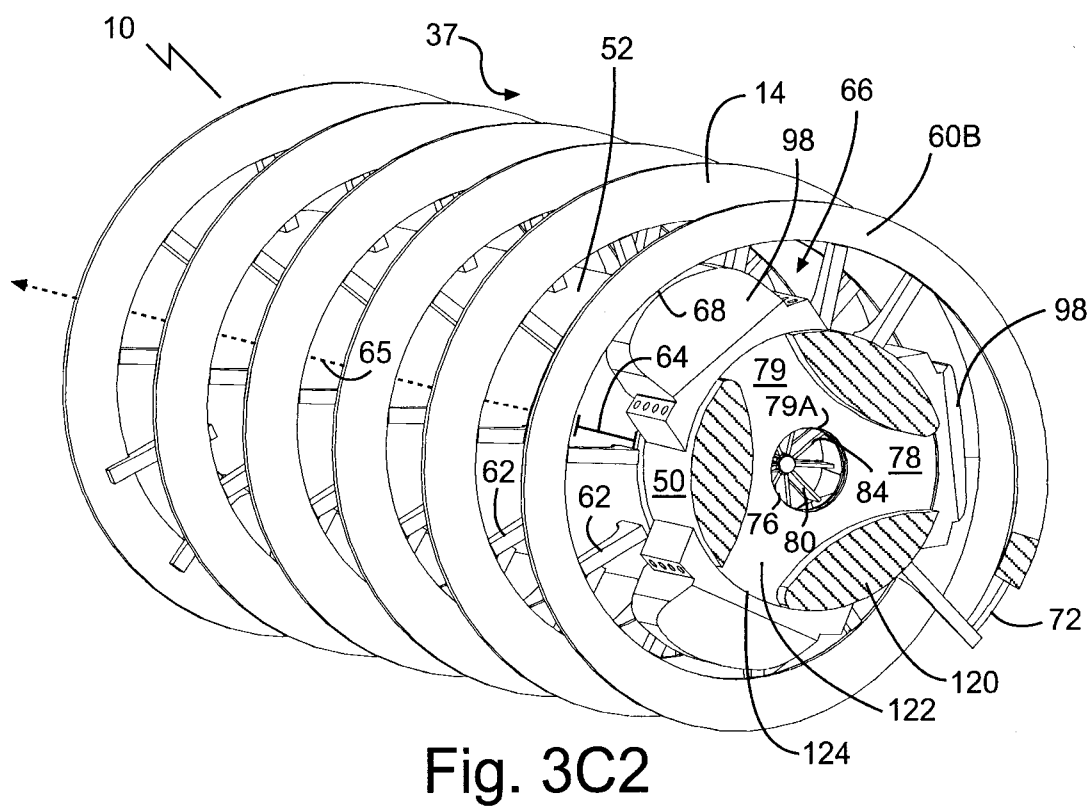
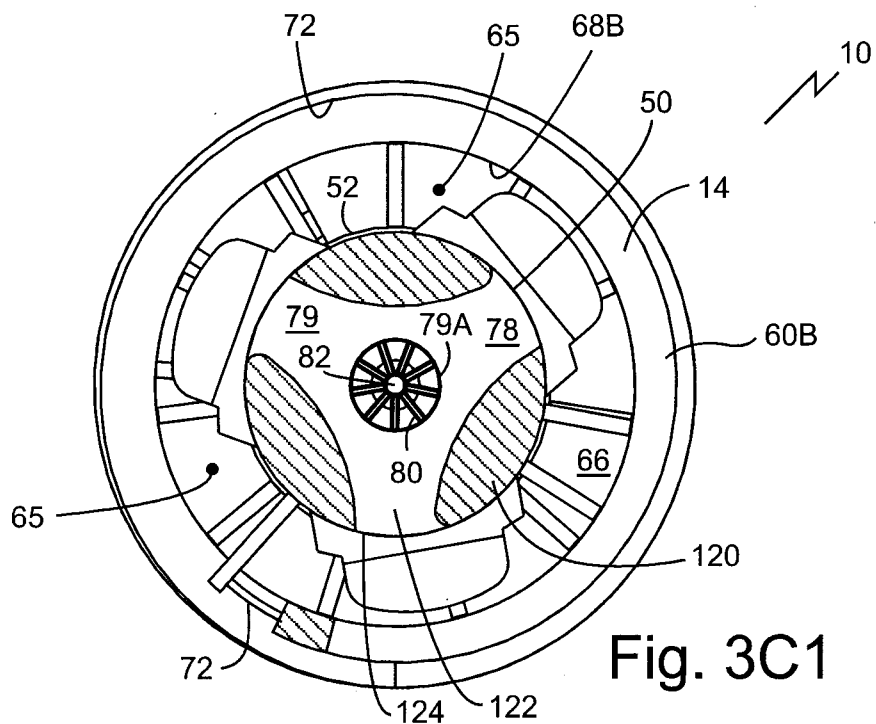


Fig. 3B1



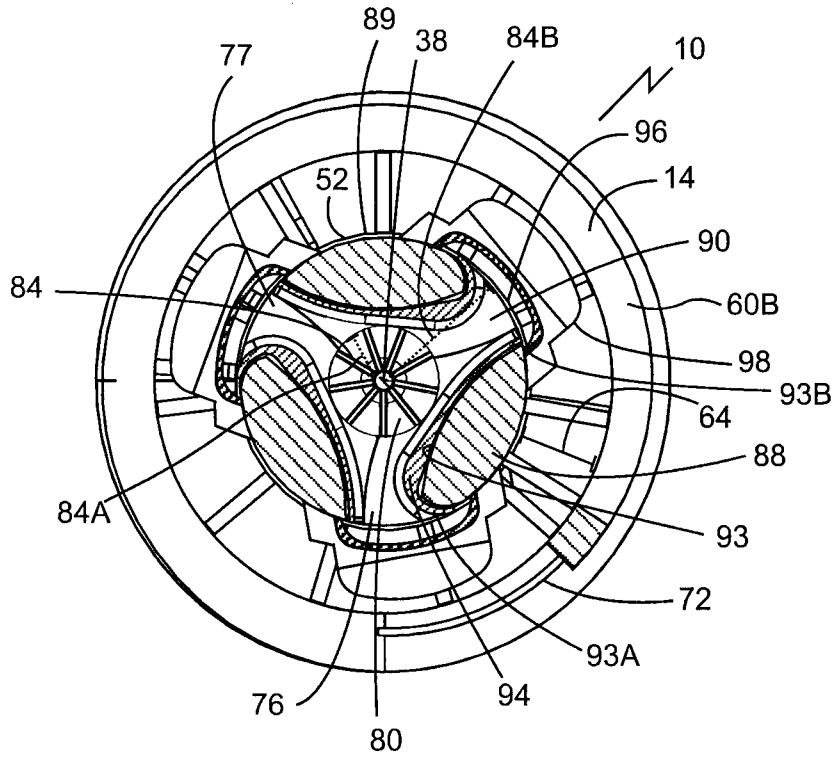


Fig. 3D1

Fig. 3D2

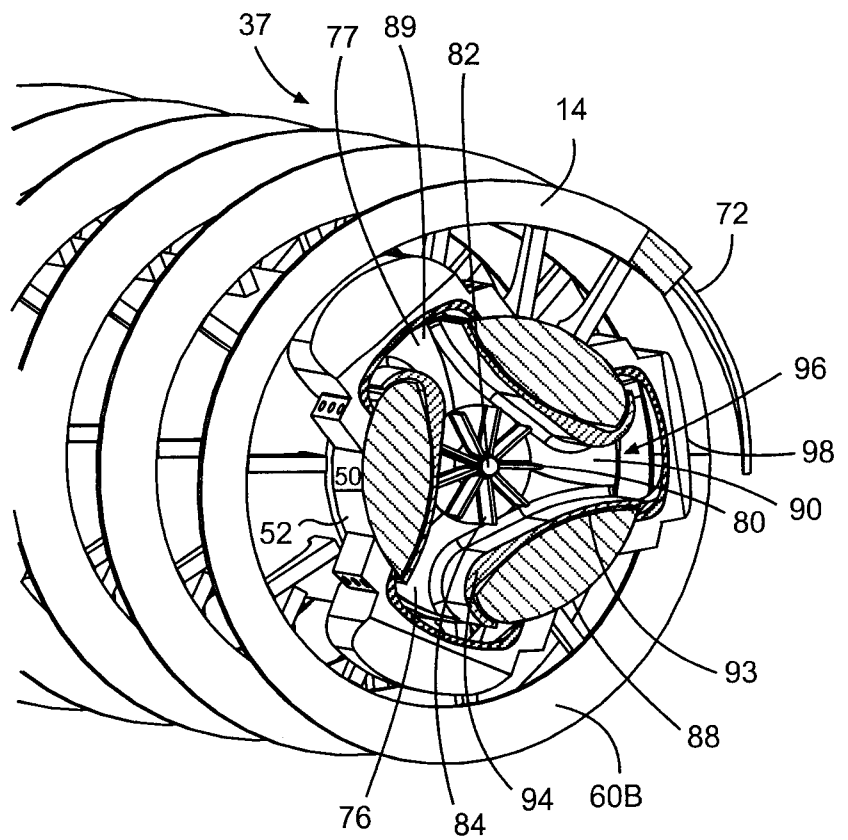


Fig. 4

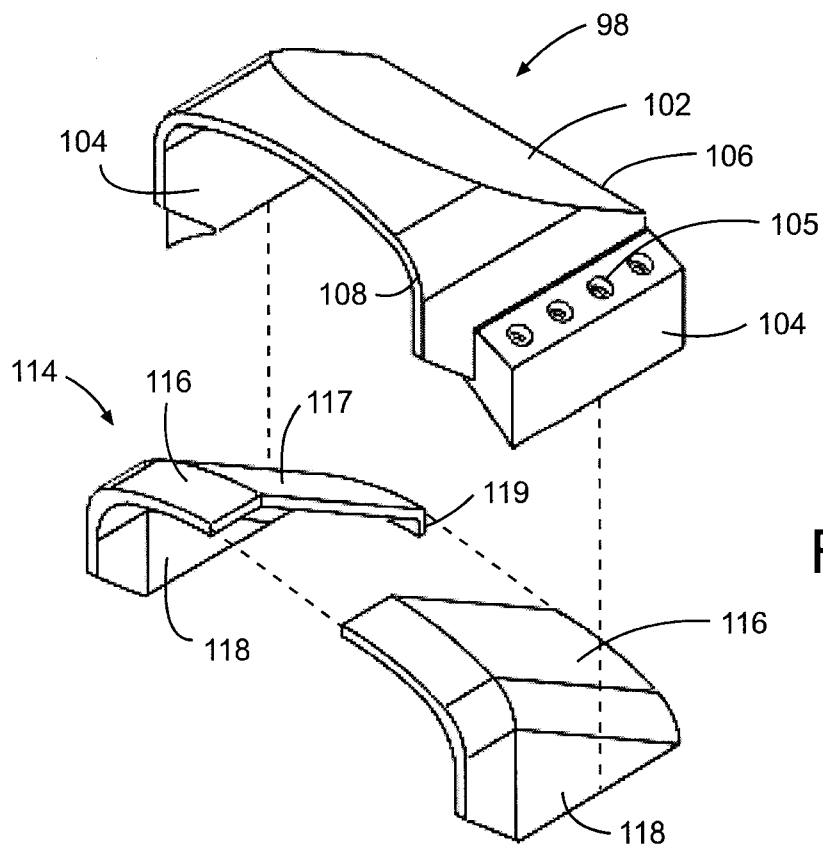
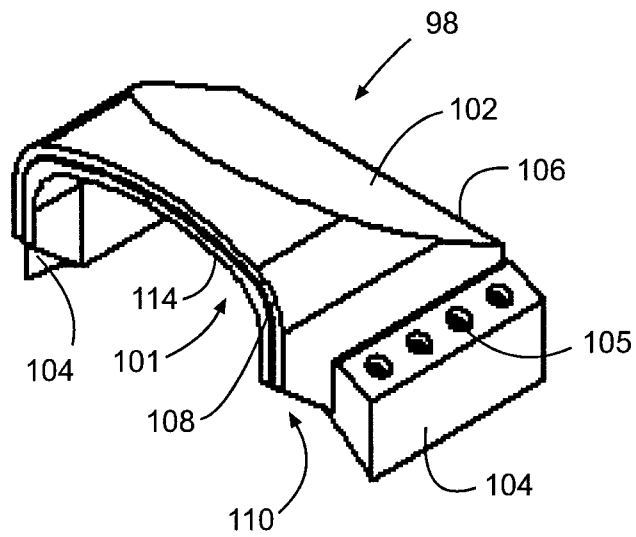


Fig. 5

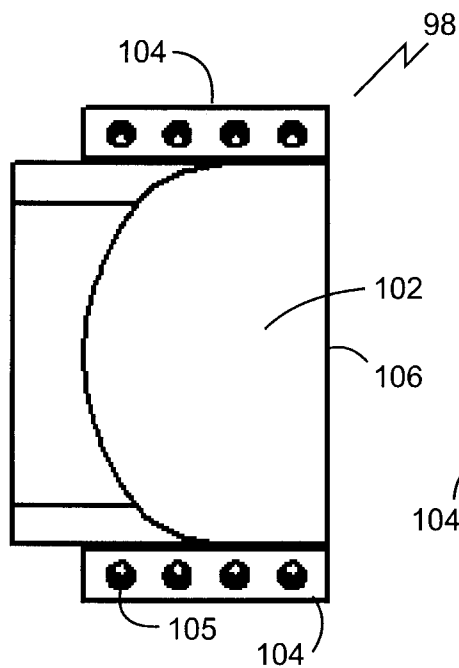


Fig. 6

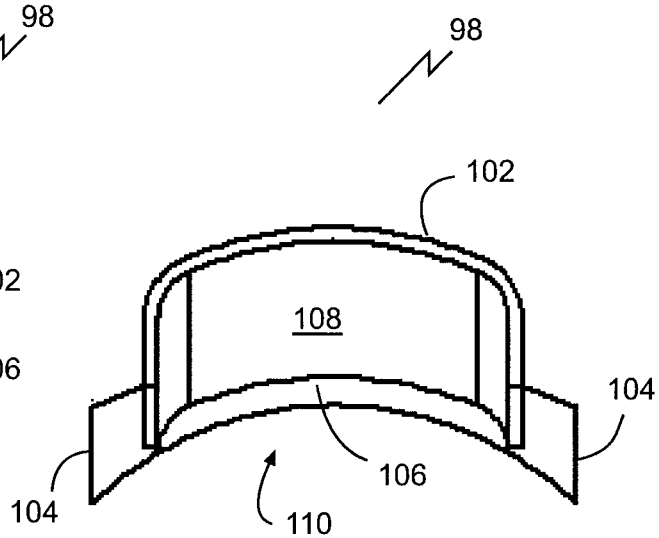


Fig. 7

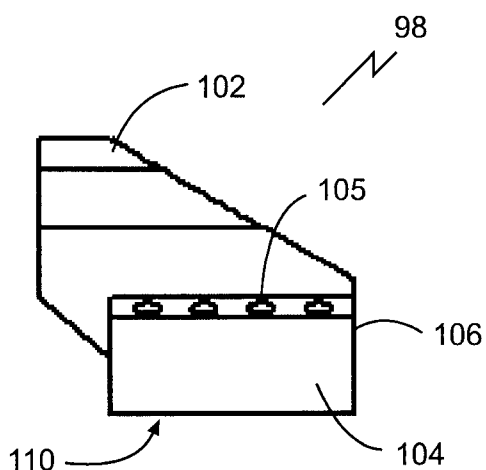


Fig. 8

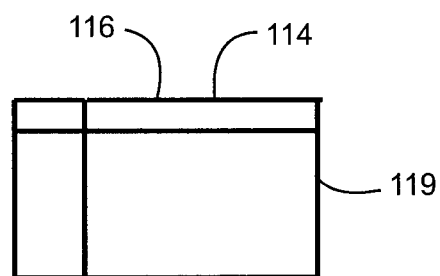


Fig. 9

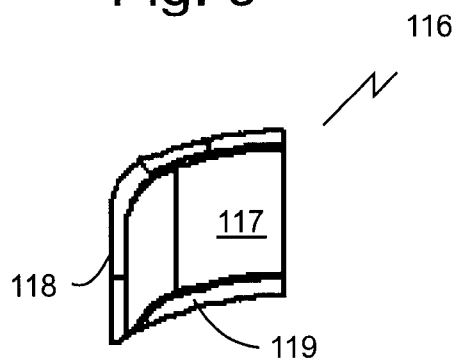


Fig. 10

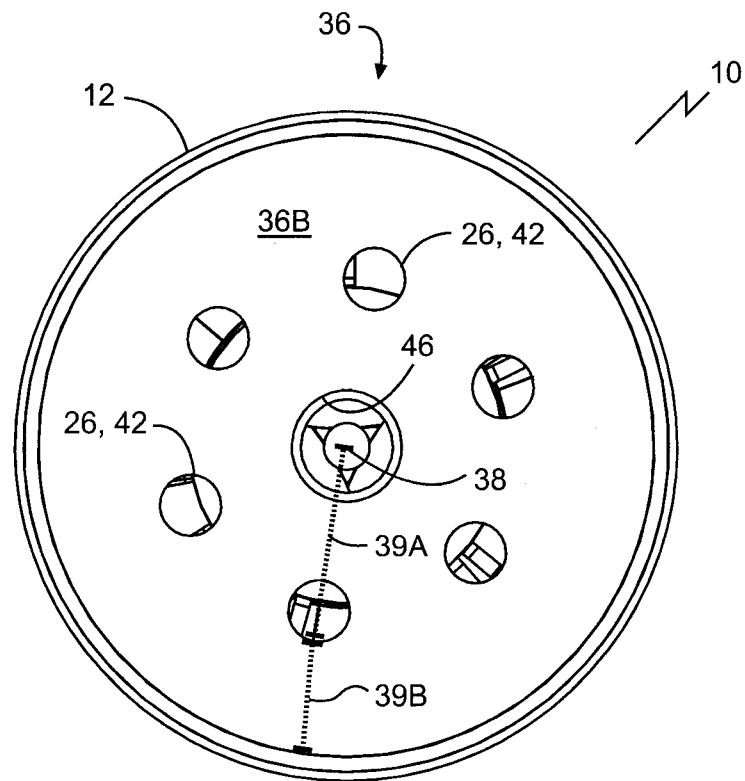


Fig. 11

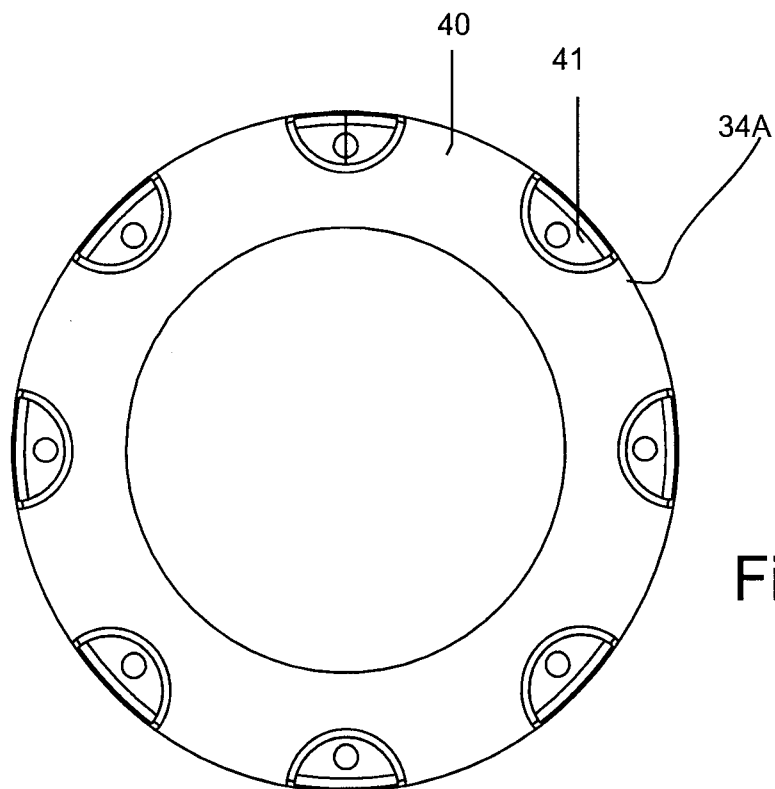


Fig. 12

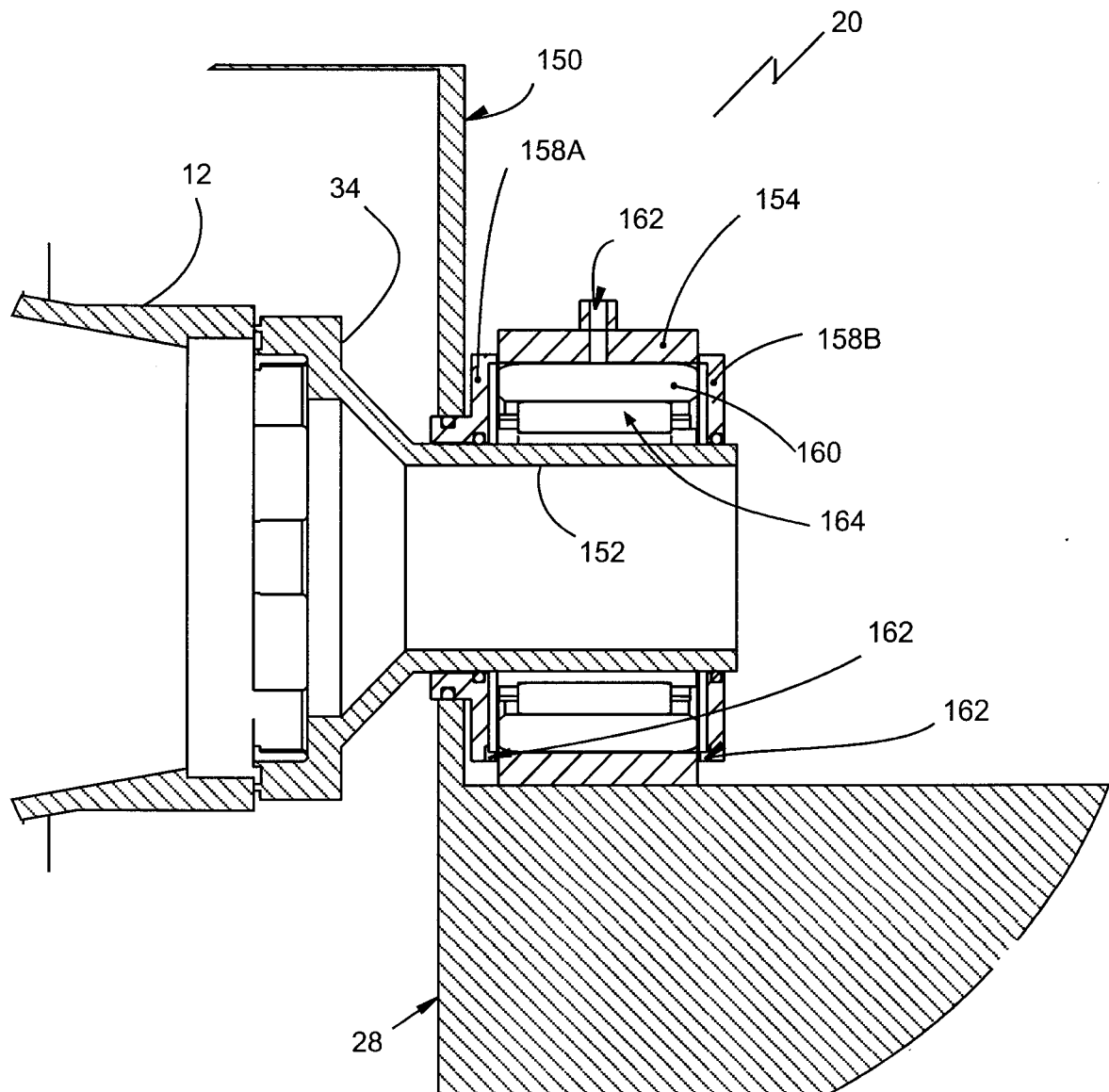


Fig. 13

